Ninety-Eighth

Meeting

of

The Electrochemical Society, Inc.

BUFFALO, NEW YORK

October 11, 12, and 13, 1950

LOCAL COMMITTEE

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MRS. AXEL HEILBORN — MRS. MARVIN J. UDY

Ninety-Eighth Meeting

Wednesday through Friday
October 11, 12, and 13

CONDENSED TECHNICAL PROGRAM

Corrosion

Wednesday morning, October 11—9:20 A.M.-12:30 P.M.
(Chinese Room)

Wednesday afternoon, October 11—2:00 P.M.-5:00 P.M.
(Chinese Room)

Thursday morning, October 12—9:00 A.M.-11:40 A.M.
(Iroquois Room)

Electro-Organic

Thursday morning, October 12—11:40 A.M.-12:20 P.M.
(Iroquois Room)

Electrothermic

Wednesday morning, October 11—9:30 A.M.-12:30 P.M.
(Fillmore Room)

Wednesday afternoon, October 11—2:00 P.M.-5:00 P.M.
(Fillmore Room)

Electrodeposition

Thursday morning, October 12—9:20 A.M.-12:00 M.
(Chinese Room)

Thursday afternoon, October 12—2:00 P.M.-4:30 P.M.
(Chinese Room)

Friday morning, October 13—9:00 A.M.-12:20 P.M.
(Chinese Room)

Friday afternoon, October 13—2:00 P.M.-4:30 P.M.
(Chinese Room)

Battery

Thursday morning, October 12—9:00 A.M.-12:00 M.
(Fillmore Room)

Thursday afternoon, October 12—2:00 P.M.-5:00 P.M.
(Fillmore Room)

Friday morning, October 13—9:00 A.M.-12:00 M.
(Fillmore Room)

Friday afternoon, October 13—2:00 P.M.-5:00 P.M.
(Fillmore Room)

GENERAL INFORMATION

Convention Headquarters will be at the Statler Hotel, Delaware Avenue at Niagara Square, Buffalo 5, New York. The registration desk will be in the Mezzanine Lounge. Parlor G will be the Society Headquarters room, Wednesday, Thursday, and Friday.

Rates for rooms will be: single room, $4.00 to $7.50; double room with double bed, $6.50 to $10.00; twin-bed room, $8.00 to $13.00; suites of living room, bedroom, and bath, $19.00 to $30.00.

Requests for room reservations should be made to Front Office Manager, Hotel Statler, Delaware Avenue at Niagara Square, Buffalo 5, New York.

REGISTRATION

The registration desk will be open Tuesday in the Mezzanine Lounge from 1:00 P.M. to 5:00 P.M.; Wednesday, 8:30 A.M. to 9:00 P.M.; Thursday, 8:30 A.M. to 5:00 P.M.; Friday, 8:30 A.M. to 5:00 P.M.

The registration fees are as follows:

Members	$6.00	Students	$1.00
Ladies	$2.00	Other nonmembers	$8.00

If a nonmember fills out an application blank and pays his first year's dues, the difference between the nonmember and member registration fee will be applied to his dues, if he is elected.

LUNCHEONS AND DINNERS

Wednesday Dinner and Entertainment

A cocktail party, at 6:30 P.M., and an informal dinner, at 7:30 P.M., will be held in the Ballroom. Entertainment, including a show by the Niagara Falls Little Theater and a square dance, will follow the dinner.

Raymond R. Ridgway Memorial Luncheon

A luncheon will be held at 12:30 P.M., Thursday, in the Niagara Room, honoring our late Past-President Raymond R. Ridgway. The speaker at this time will be Mr. Howard Daly of the Norton Company, Niagara Falls.

Acheson Medal Banquet

The Acheson Medal Banquet will be held in the Ballroom, Thursday evening, at 7:30 P.M. Preceding the banquet, at 6:30 P.M., a reception will be held for the medalist in the Ballroom Foyer. The Edward Goodrich Acheson Medal and Prize will be awarded to Dr. George W. Vinal for his distinguished contributions to the science of electrochemistry. Following presentation of the Medal and Prize by President Charles L. Faust, Dr. E. U. Condon will give a talk on Dr. Vinal's scientific accomplishments, and Dr. Marion Eppley will speak on the personal traits of the

medalist. Dr. Vinal will respond with the Medalist's Address.

After the banquet and ceremonies, a musical program will be presented by the Guido Chorus.

Friday Luncheons

There is no general Society luncheon planned at this time. However, the luncheon hour is open for group luncheons, which may be arranged directly with the hotel management by chairmen or secretaries (elected or self-appointed) of the groups. Correspondence should be directed to Mr. J. R. Hewitt, Sales Manager, Hotel Statler, Buffalo 5, New York.

A list of Division luncheons planned for this time appears on page 4 of this booklet.

Friday Evening

An informal reception will be held at the Red Coach Inn, Niagara Falls, Friday evening at 5:30 P.M. This will afford members and guests an opportunity to see the Falls both by daylight and artificial illumination, in small groups with Society members as guides. Buffet and drinks complimentary.

LADIES' PROGRAM

Wednesday Afternoon—An informal tea will be held in the Ladies' Headquarters room, 3:00 to 5:00 P.M. Complimentary.

Thursday Morning—All-day trip down the Canadian side of the Niagara River, including a luncheon in the Rainbow Room of the General Brock Hotel and a visit to Old Fort George at Niagara-on-the-Lake. (Aliens should carry passports for re-entry into the United States.) Meet at 11:00 A.M. in the Ladies' Headquarters room. Cost to guests $1.00.

Friday Afternoon—Buffalo Country Club. Meet at 12:00 noon in the Ladies' Headquarters room. Complimentary.

PLANT TRIPS

Plant trips of special interest to electrochemists are scheduled for Thursday and Friday afternoons. Buses will leave from the Hotel Statler at 1:45 P.M. Cost of each trip is $1.50.

Thursday Afternoon

Gould-National Batteries Incorporated.

Westinghouse Electric Corporation motor assembly plant.

Lionite Abrasives, Ltd., new silicon carbide plant.

Friday Afternoon

Buffalo Electro-Chemical Company installation of the contact rectifier and Huntley Station steam electric generating plant.

Colonial Radio Corporation electronic equipment plant.

E. I. du Pont de Nemours viscose plants producing rayon, cellophane, and sponge.

LUNCHEONS AND BUSINESS MEETINGS OF DIVISIONS

Battery Division—will hold its annual business meeting and election of officers at the Division Luncheon on Friday, October 13th, at 12:30 P.M. in the Niagara Room.

Corrosion Division—will hold its annual business meeting and election of officers Wednesday, October 11th, at 5:00 P.M. in the Chinese Room.

Electrodeposition Division—has scheduled its annual business meeting and election of officers for a Division luncheon, to be held Friday, October 13th, at 12:30 P.M. in Parlor A.

One of the chief items of business will be a discussion of the proposed by-laws for adoption at this time. Among the features of the by-laws is the election of officers for two years. This change will allow the Chairman and Vice-Chairman more time to arrange for future programs as outlined by the Executive Committee.

Electro-Organic Division—will hold its annual business meeting and election of officers at the Division luncheon, 12:30 P.M., Friday, October 13th, in Parlor C.

Electrothermic Division—will sponsor a luncheon on Friday, October 13th, at 12:30 P.M. in Parlor G.

BOARD AND COMMITTEE MEETINGS

Wednesday, October 11

9:00 A.M.—Meeting of the Ways and Means Committee, Parlor C.

10:30 A.M.—Meeting of the Local Section Advisory Committee, Parlor B.

2:00 P.M.—Meeting of the Board of Directors, Iroquois Room.

COST OF VARIOUS FUNCTIONS

(other than registration)

Wednesday Dinner and Entertainment	$5.00
Thursday Luncheon (Men)	$3.00
Thursday Banquet	$5.50
Plant Trips (each)	$1.50

(Note: Gratuities are included in the above costs.)

REPRINTS

Copies of the June, July, August, and September issues of the JOURNAL, containing papers presented will be available at the Registration Desk. The price of single copies of the JOURNAL is $1.00 to members and $1.25 to nonmembers.

MEETING OF ASTM COMMITTEE B-8 ON ELECTRODEPOSITED METALLIC COATINGS

Held in conjunction with the Convention of The Electrochemical Society.

Monday, October 9
and
Tuesday A.M., October 10

Closed meetings of B-8 Advisory Committee and Sections of Subcommittees.

Tuesday, October 10—Iroquois Room

(Visitors welcome at these and subsequent meetings)

1:30 P.M.—Subcommittee II on Performance Tests

3:00 P.M.—Subcommittee IV on Electroplating Practice

Wednesday, October 11—Iroquois Room

8:30 A.M.—Subcommittee V on Supplementary Treatments for Metallic Coatings

10:00 A.M.—Subcommittee I on Papers, Specifications, and Definitions

Parlor B

1:30 P.M.—Subcommittee III on Conformance Tests

3:00 P.M.—Committee B-8 on Electrodeposited Metallic Coatings

ACKNOWLEDGMENT

The Society and Local Committee wish to acknowledge the generous contributions of the following firms to the convention fund:

Alox Corporation
Buffalo Electro-Chemical Company
Carborundum Company
Cerium Metals Corporation
E. I. du Pont de Nemours & Company, Electrochemicals Dept.
Exolon Company
General Abrasive Company
Great Lakes Carbon Corporation
Hooker Electrochemical Company
International Graphite & Electrode Corporation
Isco Chemical Division, Innis Speiden & Company
Mathieson Chemical Corporation
Niagara Alakali Company
North American Cyanamid, Limited
Norton Company
Oldbury Electro-Chemical Company
Stauffer Chemical Company
Titanium Alloy Division, National Lead Company
Union Carbide and Carbon Corporation
Vanadium Corporation of America

WEDNESDAY, A.M.

DISCUSSION

There will be no recordings made of oral discussions. Those contributing to the discussion of a paper and desiring their remarks published will be supplied with a printed form on which any discussion may be written. These forms should be given to the Secretary-Treasurer of the Division at the end of the session or mailed within ten days to the Managing Editor of the JOURNAL, 235 West 102nd Street, New York 25, N. Y.

Discussions will be referred to the authors for reply. Written discussion will be accepted up to two months following publication of any article in the JOURNAL. A discussion section will be published semi-annually in the JOURNAL.

MEETING ROOM SCHEDULE

	Wednesday		Thursday		Friday	
MEETINGS	A.M.	P.M.	A.M.	P.M.	A.M.	P.M.
Corrosion	A	A	C			
Electro-Organic			C			
Electrothermic	B	B				
Electrodeposition			A	A	A	A
Battery			B	B	B	B

A—Meeting will be held in Chinese Room.
B—Meeting will be held in Fillmore Room.
C—Meeting will be held in Iroquois Room.

Technical Program

WEDNESDAY, OCTOBER 11, 1950

(CHINESE ROOM)

9:00 A.M.—Formal opening of the 98th Convention with Introduction by General Chairman Marvin J. Udy and Response by President Charles L. Faust.

Symposium on Corrosion
Theoretical Aspects of Corrosion
with Dr. I. A. Denison presiding
(CHINESE ROOM)

9:20 A.M.—Introductory remarks.

9:30 A.M.—**"Bi-metallic Corrosion in Neutral Electrolytes—A Critical Review"** by Roman T. Koenig and Carl W. Borgmann, University of Nebraska, Lincoln, Nebr. (Abstract No. 1)

10:00 A.M.—**"The Kinetics of the Oxidation of Cobalt"** by Earl A. Gulbransen and Kenneth F. Andrew, Westinghouse Research Laboratories, East Pittsburgh, Pa. (Abstract No. 2)

10:30 A.M.—**"Experiments Concerning the Mechanism of Corrosion Inhibition by Inorganic Anions"** by W. D. Robertson, Hammond Metallurgical Laboratory, Yale University, New Haven, Conn. (Abstract No. 3)

WEDNESDAY, A.M.

11:00 A.M.—"Contribution to the Theory of Cathodic Protection" by Carl Wagner, Department of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass.

(Abstract No. 4)

11:30 A.M.—"Effect of Magnetic Transformation at the Curie Temperature on Oxidation Rates of Chromium-Iron Alloys" by H. H. Uhlig and Anton de S. Brasunas, Department of Metallurgy, Massachusetts Institute of Technology, Cambridge, Mass.

(Abstract No. 5)

12:00 A.M.—"The Mechanism of Exchange between Radioactive Ions in Solution and Solid Metals" by M. T. Simnad and R. C. Ruder, Metals Research Laboratory, Carnegie Institute of Technology, Pittsburgh, Pa.

(Abstract No. 6)

(This symposium will continue at 2:00 P.M., Wednesday, October 11th, in the Chinese Room.)

Electrothermic Round Table

Electric Furnaces for Nonferrous Metals with Mr. G. K. Dreher as moderator

(FILLMORE ROOM)

9:30 A.M.-12:30 P.M.—The panel members for the Electrothermic Division's round-table discussion of "Electric Furnaces for Nonferrous Metals" will be :

B. W. Schafer, Manager, Detroit Electric Furnace Division, Kuhlman Electric Company, Bay City, Mich.

H. Russell Ogden, Jr., Battelle Memorial Institute, Columbus, Ohio.

Manuel Tama, Vice-President, Ajax Engineering Corporation, Trenton, N. J.

Frank T. Chesnut, Treasurer, Ajax Electrothermic Corporation, Trenton, N. J.

J. G. Thompson, Chief, Division of Metallurgy, National Bureau of Standards, Washington, D.C.

G. K. Dreher, Executive Director of Foundry Educational Foundation, Cleveland, Ohio.

R. L. Harper, Harper Electric Furnace Company, Niagara Falls, N. Y.

B. N. Ames, Metallurgist, Materials Research Laboratory, Brooklyn Navy Yard, Brooklyn, N.Y.

H. M. Webber, Electric Furnace Section, Industrial Heating Division, General Electric Company, Schenectady, N. Y.

Subjects to be discussed will include: indirect-arc rocking type furnace, low frequency induction furnaces, high frequency induction furnaces, indirect-arc and resistor furnaces in sand cast and investment foundry operations, and controlled atmosphere furnaces in brazing and sintering metals.

WEDNESDAY, P.M.

Symposium on Corrosion (cont'd.)

Electrical Measurements in Corrosion
with Dr. I. A. Denison presiding
(CHINESE ROOM)

2:00 P.M.—"The Kinetics of the Initial Corrosion of Copper in Aqueous Solution" by George Richard Hill, University of Utah, Salt Lake City, Utah. (Abstract No. 7)

2:30 P.M.—"Potential-pH Diagrams and their Applications to the Study of Metallic Corrosion—Aluminum, Lead, Silver, and Zinc" by Paul Delahay, Louisiana State University, Baton Rouge, La.; Marcel Pourbaix, University of Brussels, Brussels, Belgium; and Pierre Van Rysselberghe, University of Oregon, Eugene, Ore. (Abstract No. 8)

3:10 P.M.—"A Polarographic Method for the Indirect Determination of Polarization Curves for Oxygen Reduction on Various Metals" by Paul Delahay, Louisiana State University, Baton Rouge, La. (Abstract No. 9)

3:30 P.M.—"On the Application of Bridge Techniques to the Overvoltage Problem" by David C. Grahame, Amherst College, Amherst, Mass. (Abstract No. 10)

4:00 P.M.—"Studies on Galvanic Couples, III—Polarization and Cathodic Protection" by H. D. Holler, National Bureau of Standards, Washington, D. C. (Abstract No. 11)

4:30 P.M.—"Studies of Time-Potential Changes on an Electrode Surface during Current Interruption, I—Zinc-Steel Couple in Synthetic Sea Water" by Sigmund Schuldiner and Roger E. White, Naval Research Laboratory, Washington, D. C. (Abstract No. 12)

5:00 P.M.—Corrosion Division's annual business meeting and election of officers for the coming year.

(This symposium will continue at 9:00 A.M., Thursday, October 12th, in the Iroquois Room.)

Electrothermic Round Table

Electric Furnaces in the Processing of Nonmetals
with Mr. G. J. Easter as moderator
(FILLMORE ROOM)

2:00 P.M.-5:00 P.M.—The panel members for the Electrothermic Division's round-table discussion of "Electric Furnaces in the Processing of Nonmetals" will be:

R. B. Burt, In Charge Chemical Plant Control, Electric Furnace Plant, TVA, Wilson Dam, Ala.

M. M. Striplin, Jr., Development Section, TVA, Wilson Dam, Ala.

THURSDAY, A.M.

Robert MacDonald, Jr., Vice-President, General Abrasive Company, Niagara Falls, N. Y.

R. A. Webber, Works Manager, Electro Refractories & Alloys Corporation, Trois Rivieres, Quebec, Canada.

M. J. Udy, Consultant, Niagara Falls, N. Y.

Hewitt Wilson, Regional Director, Bureau of Mines, Norris, Tenn.

R. L. Harper, Harper Electric Furnace Company, Niagara Falls, N. Y.

J. A. Shaw, Technical Advisor, International Graphite and Electrode Corporation, Niagara Falls, N. Y.

Subjects to be discussed will include: phosphate production, silicon carbide, fused alumina, graphite and carbon, phosphorus, and electric furnacing of ceramic products.

Note: The Raymond R. Ridgway Luncheon, to be held Thursday, October 12th, will be of interest to the Electrothermic Division. It will be followed by a trip to the new silicon carbide plant of Lionite Abrasives, Ltd., a subsidiary of the General Abrasive Company.

The luncheon sponsored by the Electrothermic Division will be held at 12:30 P.M., Friday, October 13th, in Parlor G.

THURSDAY, OCTOBER 12, 1950

Symposium on Corrosion (cont'd.)
Corrosion in Solutions
with Dr. I. A. Denison presiding
(IROQUOIS ROOM)

9:00 A.M.—"Dichromate Reduction Rate at a Steel Surface in Air-Free, Acetic Acid Solution" by Norman Hackerman and Ray M. Hurd, University of Texas, Austin, Tex. (Abstract No. 13)

9:25 A.M.—"Rate of Dissolution of Silver in Aqueous Ceric Sulfate Solutions" by H. W. Salzberg, H. K. Knoetgen, and H. M. Molless, New York University, New York, N. Y. (Abstract No. 14)

9:50 A.M.—"The Rate of Corrosion of Silver in Solutions of Ferric Sulfate" by H. W. Salzberg and Cecil V. King, New York University, New York, N. Y. (Abstract No. 15)

10:15 A.M.—"The Electrochemical Behavior of Aluminum, II—In Solutions of Iron Sulfate" by J. V. Petrocelli, The Patent Button Company, Waterbury, Conn. (Abstract No. 16)

10:40 A.M.—"Corrosion Rate and Etch Structures of Aluminum; Effect of Heat Treatment and Impurities" by B. Roald and M. A. Streicher, Lehigh University, Bethlehem, Pa. (Abstract No. 17)

THURSDAY, A.M.

10:55 A.M.—"The Influence of Surface Active Agents on Pickling Brittleness in Carbon and Stainless Steel" by Carl A. Zapffe and M. Eleanor Haslem, 6410 Murray Hill Road, Baltimore, Md. (Abstract No. 18)

11:20 A.M.—"Metal-Solution Potentials of Nickel in Foreign Ion Solutions and the Mechanism of Nickel Corrosion" by D. MacGillavry and J. H. Rosenbaum, Clark University, Worcester, Mass. (Abstract No. 18a)

Session on Electro-Organic Chemistry
with Dr. C. A. Crowley presiding

(IROQUOIS ROOM)

11:40 A.M.—"Electrochemical Reduction of Nitroalkanes" by Morton W. Leeds, Schwarz Laboratories, New York, N. Y., and G. B. L. Smith, Research Department, U. S. Naval Ordnance Test Station, Inyokern, Calif. (Abstract No. 19)

12:05 P.M.—"The Electrolytic Reduction of Salicylic and Acetylsalicylic Acids to the Corresponding Aldehydes" by James A. May, The Dow Chemical Company, Freeport, Tex., and Kenneth A. Kobe, University of Texas, Austin, Tex. (Abstract No. 20)

Symposium on Electrodeposition

Preparation of the Cathode for Plating
with Dr. R. A. Schaefer presiding

(CHINESE ROOM)

9:20 A.M.—Introductory remarks.

Adhesion

9:30 A.M.—"Surface Preparation of Nickel Silver, Brass, and Copper for Electroplating" by Daniel Gray, Oneida, Ltd., Oneida, N. Y. (Abstract No. 21)

10:00 A.M.—"Cleaning and Etching of Aluminum Alloys" by Walter R. Meyer, Enthone, Inc., New Haven, Conn. (Abstract No. 22)

10:30 A.M.—"Diphase Metal Cleaning in Electroplating" by Foster Dee Snell and Irving Reich, Foster D. Snell, Inc., New York, N. Y. (Abstract No. 23)

Non-Adhesion

11:00 A.M.—"The Relative Reliability of Aluminum and Zinc Starting Sheets for the Electrodeposition of Zinc" by Glen C. Ware and Kenneth B. Higbie, Bureau of Mines, U. S. Department of the Interior, Albany, Ore. (Abstract No. 24)

THURSDAY, P.M.

11:30 A.M.—"Zirconium and Titanium as Cathode Materials for the Electrodeposition of Zinc" by Glen C. Ware and Kenneth B. Higbie, Bureau of Mines, U. S. Department of the Interior, Albany, Ore. (Abstract No. 25)

(This symposium will continue at 2:00 P.M., Thursday, October 12th, in the Chinese Room.)

Symposium on Batteries
Primary Cells
with Dr. J. N. Mrgudich presiding
(FILLMORE ROOM)

9:00 A.M.—"The Mechanism of the Discharge of the Manganese Dioxide Electrode" by D. Thomas Ferrell, Jr., and W. C. Vosburgh, Duke University, Durham, N. C. (Abstract No. 45)

9:30 A.M.—"The Mechanism of the Self-Discharge of Cells with Manganese Dioxide Electrodes" by Charles W. Jennings and W. C. Vosburgh, Duke University, Durham, N. C. (Abstract No. 46)

10:00 A.M.—"Distribution of Current in Porous Electrodes" by J. J. Coleman, Burgess Battery Company, Freeport, Ill. (Abstract No. 47)

10:30 A.M.—"Miniature High Capacity R-M Cells" by Richard Clune, P. R. Mallory & Company, Inc., Indianapolis, Ind. (Abstract No. 48)

11:00 A.M.—"Silver Permanganate and Persulfate as Depolarizers in Primary Batteries" by Paul L. Howard, National Bureau of Standards, Washington, D. C. (Abstract No. 49)

11:30 A.M.—"Magnesium Dry Cells" by R. C. Kirk, D. F. George, and A. B. Fry, Dow Chemical Company, Midland, Mich. (Abstract No. 50)

(This symposium will continue at 2:00 P.M., Thursday, October 12th, in the Fillmore Room.)

Symposium on Electrodeposition, (cont'd.)
Evaluation of a Clean Cathode
with Dr. R. A. Schaefer, presiding
(CHINESE ROOM)

2:00 P.M.—"Water-Break Type Tests for the Evaluation of Metal Cleaning" by S. Spring, Pennsylvania Salt Manufacturing Company, Wyndmoor, Pa. (Abstract No. 26)

2:30 P.M.—"The Detection and Estimation of Oils on Metal Surfaces With Ultraviolet Light Procedures" by O. M. Morgan and L. F. Hoyt, National Aniline Division, Allied Chemical & Dye Corporation, New York, N. Y. (Abstract No. 27)

THURSDAY, P.M.

3:00 P.M.—"Detection of Soil Removal in Metal Cleaning by the Radioactive Tracer Technique" by J. C. Harris, R. E. Kamp, and W. H. Yanko, Central Research Department Monsanto Chemical Company, Dayton, Ohio. (Abstract No. 28)

3:30 P.M.—"Soil Removal Testing and Cleanliness Evaluation" by A. Mankowich, Aberdeen Proving Ground, Md. (Abstract No. 29)

4:00 P.M.—"The Ascyclic Generator for Electrolytic Processing" by Gordon J. Berry, The Electric Products Company, Cleveland, Ohio. (Abstract No. 30)

(This symposium will continue at 9:00 A.M., Friday, October 13th, in the Chinese Room.)

Symposium on Batteries (cont'd.)
Primary Cells
with Mr. George W. Heise presiding

(FILLMORE ROOM)

2:00 P.M.—"Calcium Chloride Low Temperature Dry Cells" by Earl Otto and Harold J. DeWane, National Bureau of Standards, Washington, D. C. (Abstract No. 51)

2:30 P.M.—"Discharge Characteristics of Leclanché Dry Cells" by John J. Murphy, Signal Corps Engineering Laboratories, Fort Monmouth, N. J. (Abstract No. 52)

2:55 P.M.—"Empirical Equation for the Determination of Dry Cell Capacities at 70° F" by Charles H. Clark, Signal Corps Engineering Laboratories, Fort Monmouth, N. J. (Abstract No. 53)

3:20 P.M.—"The Electrochemical Evaluation of Manganese Dioxide for Dry Battery Use" by N. C. Cahoon, National Carbon Research Laboratories, Cleveland, Ohio. (Abstract No. 54)

3:45 P.M.—"Determination of Volatile Matter in Blacks" by G. Benson, Shawinigan Chemicals, Ltd., Shawinigan Falls, Quebec, Canada. (Abstract No. 55)

4:10 P.M.—"Nigrometer Readings vs. Particle Size of Blacks" by K. Kaufman, Shawinigan Chemicals, Ltd., Shawinigan Falls, Quebec, Canada. (Abstract No. 56)

4:35 P.M.—"S. C. E. L. Primary Battery — Research and Development Program" by Arthur F. Daniel, Signal Corps Engineering Laboratories, Fort Monmouth, N. J. (Abstract No. 57)

(This symposium will continue at 9:00 A.M., Friday, October 13th, in the Fillmore Room.)

FRIDAY, OCTOBER 13, 1950

Symposium on Electrodeposition, (cont'd.)

The Cathode or Anode during Electrolytic Processes with Dr. R. A. Woofter presiding

(CHINESE ROOM)

9:00 A.M.—"The Cathode Polarization Potential during the Electrodeposition of Copper, I —The Apparent Instability of Acid Copper Sulfate Solutions and the Production of Solutions of Consistent Characteristics" by L. L. Shreir and J. W. Smith, Bedford College for Women (University of London), London, England. (Abstract No. 31)

9:20 A.M.—"Theoretical Analysis of the Current Density Distribution in Galvanic Baths" by Carl Wagner, Department of Metallurgy, Massachusetts Institute of Technology. Cambridge, Mass. (Abstract No. 32)

9:45 A.M.—"Plating Experiments with Aqueous Solutions at High Temperatures" by Seymour Senderoff and Abner Brenner, National Bureau of Standards, Washington, D. C. (Abstract No. 33)

10:10 A.M.—"The Anode Layer in the Electrolytic Polishing of Copper" by H. F. Walton, University of Colorado, Boulder, Colo. (Abstract No. 34)

10:35 A.M.—"Studies of Hydrogen Embrittlement in Cadmium Plated Steel" by Robert Weast, Case Institute of Technology, Cleveland, Ohio. (Abstract No. 35)

11:00 A.M.—"Mechanism of Mass Transfer in Cathode Films during Electrodeposition" by Robert R. Banks and Henry B. Linford, Columbia University, New York, N. Y. (Abstract No. 36)

The Cathode Deposit

11:30 A.M.—"Electrodeposition of Metal Powders" by Gustaf Wranglen, Electrodeposition Section, National Bureau of Standards, Washington, D. C. (Abstract No. 37)

11:55 A.M.—"Electrolytic Hexagonal Nickel" by Ling Yang, Frick Chemical Laboratory, Princeton University, Princeton, N. J. (Abstract No. 38)

12:30 P.M.—Electrodeposition Luncheon and Annual Business Meeting in Parlor A.

(This symposium will continue at 2:00 P.M., Friday, October 13th, in the Chinese Room.)

FRIDAY, A.M.

Symposium on Batteries, (cont'd.)
Secondary Cells
with Dr. Eugene Willihnganz presiding

(FILLMORE ROOM)

9:00 A.M.—"Battery Loads vs. Battery Performance" by H. C. Riggs, The Electric Storage Battery Company, Philadelphia, Pa. (Abstract No. 58)

9:30 A.M.—"Behavior of the Components of Expanders for Lead-Acid Storage Batteries" by A. C. Zachlin, Willard Storage Battery Company, Cleveland, Ohio. (Abstract No. 59)

10:00 A.M.—"Practical Appraisal of Addition Agent in Negative Plates of Lead Storage Batteries" by D. H. Haskell, W. P. Fuller & Company, South San Francisco, Calif. (Abstract No. 60)

10:30 A.M.—"Addition Agents for Negative Plates of Lead-Acid Storage Batteries, II—Pure Organic Compounds" by E. J. Ritchie, Eagle-Picher Company, Joplin, Mo. (Abstract No. 61)

11:00 A.M.—"The Effect of Magnesium Sulfate and Sodium Sulfate on Lead-Acid Batteries" by Paul L. Howard and G. W. Vinal, National Bureau of Standards, Washington, D. C. (Abstract No. 62)

11:30 A.M.—"Storage Battery 'Dopes'" by C. C. Rose, Willard Storage Battery Company, Cleveland, Ohio. (Abstract No. 63)

12:30 P.M.—Battery Luncheon and business meeting in the Niagara Room.

(This symposium will continue at 2:00 P.M., Friday, October 13th, in the Fillmore Room.)

Symposium on Electrodeposition, (cont'd.)
with Dr. R. A. Woofter, presiding

(CHINESE ROOM)

2:00 P.M.—"Improvements in the Electrowinning of Chromium" by R. R. Lloyd, J. B. Rosenbaum, V. E. Homme, L. P. Davis, and C. C. Merrill, Minerals Division, Bureau of Mines, U. S. Department of the Interior, Boulder City, Nev. (Abstract No. 39)

2:25 P.M.—"The Effect of Pure Organic Compounds on Crystal Size in Copper Electrodeposition, I" by Martin Chanin, William P. Roth, Herbert R. Roth, and John H. Lane, Evansville College, Evansville, Ind. (Abstract No. 40)

2:50 P.M.—"The Effect of Indium in Electrodeposited Chromium" by Norman Hackerman

and Tyleen Jensen, University of Texas, Austin, Tex. (Abstract No. 41)

3:15 P.M.—"Electrodeposition of Rhenium-Nickel Alloys" by L. E. Netherton, Victor Chemical Company, Chicago Heights, Ill., and M. L. Holt, Chemistry Department, University of Wisconsin, Madison, Wis. (Abstract No. 42)

3:40 P.M.—"New Correlative Instrumental Analyses of Textures and Properties of Nickel Electrodepositing" by George L. Clark, University of Illinois, Chicago, Ill., and Stanley H. Simonsen, University of Texas, Austin, Tex. (Abstract No. 43)

4:05 P.M.—"Preparation of Fine Wire by Electropolishing" by William H. Colner, Morris Feinleib, and Howard T. Francis, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill. (Abstract No. 44)

Symposium on Batteries, (cont'd.)
Secondary Cells
with Dr. Eugene Willihnganz presiding
(FILLMORE ROOM)

2:00 P.M.—"The Effect of Pig Lead Composition on the Life and Capacity of Lead Batteries" by D. H. Haskell, W. P. Fuller & Company, South San Francisco, Calif. (Abstract No. 64)

2:25 P.M.—"The Constant Potential Anodization of Lead in Sulfuric Acid Solutions" by John J. Lander, Naval Research Laboratory, Washington, D. C. (Abstract No. 65)

2:50 P.M.—"Some Preliminary Studies of Positive Grid Corrosion in the Lead-Acid Cell" by John J. Lander, Naval Research Laboratory, Washington, D. C. (Abstract No. 66)

3:15 P.M.—"Construction and Performance of Plastic Container Electrolyte-Retaining Lead-Acid Batteries" by C. H. Endress and C. C. Rose, Willard Storage Battery Company, Cleveland, Ohio. (Abstract No. 67)

3:40 P.M.—"The Hydroset Process for Lead Storage Battery Plates" by R. H. Greenburg, F. B. Finan, and B. Agruss, National Lead Company, Research Laboratories, Brooklyn, N. Y. (Abstract No. 68)

4:05 P.M.—"Float Characteristics of Lead Batteries" by U. B. Thomas, Bell Telephone Laboratories, Murray Hill, N. J. (Abstract No. 69)

4:30 P.M.—"Nickel-Cadmium Batteries for Military Use" by G. B. Ellis, U. S. Signal Corps Engineering Laboratories, Fort Monmouth, N. J. (Abstract No. 70)

ABSTRACTS

CORROSION

ABSTRACT NUMBER 1

BI-METALLIC CORROSION IN NEUTRAL ELECTROLYTES—A CRITICAL REVIEW

Roman T. Koenig and Carl W. Borgmann
University of Nebraka
Lincoln, Nebraska

THE literature is reviewed carefully. The amount of fundamental work in this important field is surprisingly limited. The basic concepts are qualitatively quite consistent with modern electrochemical theory of corrosion. Electrode polarization and resistance control of the amount of corrosion is discussed at length. The factors influencing corrosion distribution at the junction are considered. Stress is placed on the influence of environment and topographical relationships of the two metals. The gaps in our knowledge—particularly from a quantitative standpoint—are indicated, together with suggestions of further experimental work.

ABSTRACT NUMBER 2

THE KINETICS OF THE OXIDATION OF COBALT

Earl A. Gulbransen and Kenneth F. Andrew
Westinghouse Research Laboratories
East Pittsburgh, Pennsylvania

A STUDY is made of the reactions of rolled cobalt strip with oxygen over the temperature range of 250° to 700°C. The data may be fitted to the parabolic rate law except for the initial period of reaction. An energy of activation of 16,450 calories per mole is calculated from a plot of log K/T vs. $1/T$. Cobalt is found to oxidize faster than iron, tantalum, columbium, titanium, zirconium, aluminum, and beryllium in this temperature range. The results are compared to recent high temperature studies summarized in a recent work by Valensi ("la metallurgia italiana" n. 3 marzo 1950).

No appreciable reaction of cobalt with nitrogen or hydrogen is observed.

ABSTRACT NUMBER 3

EXPERIMENTS CONCERNING THE MECHANISM OF CORROSION INHIBITION BY INORGANIC ANIONS

W. D. Robertson*
Institute for the Study of Metals
University of Chicago, Chicago, Illinois

EXPERIMENTS have been conducted to clarify certain aspects of the problem of inhibition by inorganic anions including (1) a collection of self-consistent data on corrosion rates of iron in oxygen-saturated distilled water containing various anions which indicates that molybdates and tungstates are comparable with chromates as inhibitors; (2) relative oxidizing power of the different anions for the ferrous-ferric ion couple; and (3) the relative precipitating power of the anions for a positively charged ferric oxide sol.

Comparison of the effect of the anions in terms of oxidizing power, structure, charge, and central element indicates that previous explanations regarding the mechanism of inhibition may require modification.

* Present address: Hammond Metallurgical Laboratory, Yale University, New Haven, Connecticut.

ABSTRACT NUMBER 4

CONTRIBUTION TO THE THEORY OF CATHODIC PROTECTION

Carl Wagner
Department of Metallurgy
Massachusetts Institute of Technology
Cambridge, Massachusetts

THE distribution of the electrical potential inside an electrolytic solution has been calculated for typical cases of cathodic protection involving an auxiliary metal to be sacrificed. These calculations have been used to work out equations and diagrams which permit prediction of the maximum extension of metallic surfaces for which cathodic protection can be accompiished. Decisive factors are (1) the electrical conductivity of the corroding solution, and (2) the current density for the cathodic reduction of oxidizers present, equivalent to the diffusion rate of oxidizers from the bulk solution toward the metallic surface to be protected.

ABSTRACT NUMBER 5

EFFECT OF MAGNETIC TRANSFORMATION AT THE CURIE TEMPERATURE ON OXIDATION RATES OF CHROMIUM-IRON ALLOYS

H. H. Uhlig and Anton de S. Brasunas
Department of Metallurgy
Massachusetts Institute of Technology
Cambridge, Massachusetts

OXIDATION rates of chromium-iron alloys containing 9.2 to 24 per cent chromium have been carried out in oxygen at temperatures above and below the Curie temperatures. Plots of the logarithms of the oxidation rates with the reciprocal absolute temperatures show discontinuities at the Curie temperatures. In general activation energies calculated from the oxidation rate data are higher above the Curie temperatures than below.

The data support the view that rate of formation of thin films is controlled by reaction phenomena at the metal-oxide interface rather than diffusion through oxide. Rideal and Jones showed earlier that the rate-controlling step may involve transfer of electrons from the metal; therefore, a higher work function for the metal above than below the Curie temperatures may be associated with the observed trend of activation energy.

Since the Curie temperature is an electronic transition, the data also support the view that electronic changes in the chromium-iron alloys can affect the initial reaction rates.

ABSTRACT NUMBER 6

THE MECHANISM OF EXCHANGE BETWEEN RADIOACTIVE IONS IN SOLUTION AND SOLID METALS

M. T. Simnad and R. C. Ruder
Metals Research Laboratory
Carnegie Institute of Technology
Pittsburgh, Pennsylvania

THE mechanism of exchange between metals and ions in solution has been studied with radioactive cobalt ions in solutions into which various metals with different surface treatments were immersed in the presence and absence of oxygen. The metals were washed after various times of immersion in the solutions, their acquired radioactivities measured, and the distribution of radioactive cobalt on the surfaces

shown by means of autoradiographs. The results indicate that local cell action, due to differences of potential on the metal surfaces, is the factor which governs the radioactivity acquired by the metals.

ABSTRACT NUMBER 7

THE KINETICS OF THE INITIAL CORROSION OF COPPER IN AQUEOUS SOLUTION

George Richard Hill
University of Utah
Salt Lake City, Utah

IN ORDER to determine the mechanism and activation energy of the corrosion of copper in aqueous solutions before diffusion through a film of products becomes rate determining, a system involving an electroreduction cell coupled to a recording electronic voltmeter has been constructed which makes possible the determination of the thickness of very thin films of corrosion products on the copper surface. Cleaned copper samples are allowed to corrode for short periods of time under precisely controlled conditions and the rate of corrosion determined as a function of the concentrations of reacting species and the temperature.

ABSTRACT NUMBER 8

POTENTIAL-pH DIAGRAMS AND THEIR APPLICATIONS TO THE STUDY OF METALLIC CORROSION

Aluminum, Lead, Silver, and Zinc

Paul Delahay
Louisiana State University
Baton Rouge, Louisiana

Marcel Pourbaix
University of Brussels
Brussels, Belgium
and
Pierre Van Rysselberghe
University of Oregon
Eugene, Oregon

THE successive steps in the construction of a potential-pH diagram are briefly discussed for the typical case of lead. The use of thermodynamic data in the method of construction is presented. The application of potential-pH diagrams

to the interpretation of the electrochemical properties of a metal is discussed. Domains of corrosion, passivity, and passivation can be determined on the diagram. Examples are presented for lead, zinc, aluminum, and silver. The modifications of the diagram resulting from the presence of dissolved carbon dioxide are discussed. New diagrams showing the domains of corrosion, passivation, and passivity in presence of carbon dioxide are presented for lead and zinc. Possible applications of the diagrams in the study of corrosion problems are discussed.

ABSTRACT NUMBER 9

A POLAROGRAPHIC METHOD FOR THE INDIRECT DETERMINATION OF POLARIZATION CURVES FOR OXYGEN REDUCTION ON VARIOUS METALS

Paul Delahay

University of Oregon
Eugene, Oregon*

AN INDIRECT method for determining polarization curves for the electrolytic reduction of oxygen is described and applied to the case of ten metals. The electrode, on which the oxygen reduction is studied, is polarized at a constant potential in a closed vessel containing a solution initially saturated with air. The oxygen concentration is determined by the polarographic method at various time intervals. The current for oxygen reduction is calculated from these data. The complete polarization curve is determined by repeating the experiment for several values of the potential of the electrode. The contributions of the two- and four-electron reduction processes, i.e., reductions of oxygen to hydrogen peroxide and to water, respectively, are also calculated. The method is applied to the following metals: platinum, aluminum, zinc, magnesium, nickel, iron, silver, copper, tin, and lead. The first four metals favor hydrogen peroxide production. With the other metals only small amounts of hydrogen peroxide were detected. Polarization curves for oxygen reduction are compared with conventional curves. Equilibrium conditions for anodic processes are derived from thermodynamic data for some of the metals investigated. Possible consequences of the production of hydrogen peroxide in corrosion reactions are briefly discussed.

* Present address: Louisiana State University, Baton Rouge, Louisiana.

ABSTRACT NUMBER 10

ON THE APPLICATION OF BRIDGE TECHNIQUES TO THE OVERVOLTAGE PROBLEM

David C. Grahame
Amherst College
Amherst, Massachusetts

THE current-interrupter method has long been applied to the measurement of overvoltage on metals. An experimental difficulty arises in that the measurement of potential must be made in essentially zero time after the interruption of current. Radar-type techniques can be used for this measurement, but so also can bridge measurements. This follows directly from the fact that both methods give the impedance as a function of frequency and no other information. The technique of applying bridge measurements for this purpose will be discussed. It will be shown that a simple bridge measurement at a single frequency gives as much information for this purpose as is available experimentally.

ABSTRACT NUMBER 11

STUDIES ON GALVANIC COUPLES

III. Polarization and Cathodic Protection

H. D. Holler
National Bureau of Standards
Washington, D. C.

THE mechanism of polarization of a galvanic couple is developed. By means of separate elements in an electric network, the roles of electrode potentials and of resistive-potential differences are demonstrated in polarization and cathodic protection. Several methods of showing the relation between polarizing current and galvanic-couple potential are discussed. The electrical conditions which determine the distribution of current flowing to a galvanic couple are defined. The use of the term "current density" in cathodic protection should be carefully qualified; otherwise, it may be meaningless.

ABSTRACT NUMBER 12

STUDIES OF TIME-POTENTIAL CHANGES ON AN ELECTRODE SURFACE DURING CURRENT INTERRUPTION

I. Zinc-Steel Couple in Synthetic Sea Water

Sigmund Schuldiner and Roger E. White
Naval Research Laboratory
Washington, D. C.

A D-C interrupter method has been developed for oscilloscopic studies of time-potential changes at an electrode surface during short interruption intervals. This technique permitted correction for the resistance error in closed circuit potential measurements. Polarization decay and build-up could be followed as the current was turned off or on in 0.15 microsecond, and the potential changes and double-layer capacity effects occurring at an electrode surface could be measured. These phenomena have been discussed in terms of an equivalent electrical circuit. A study of polarization phenomena on zinc and steel coupled together in synthetic sea water was completed.

ABSTRACT NUMBER 13

DICHROMATE REDUCTION RATE AT A STEEL SURFACE IN AIR-FREE, ACETIC ACID SOLUTION

Norman Hackerman and Ray M. Hurd
University of Texas
Austin, Texas

A SYSTEM was devised in which aqueous solutions of $K_2Cr_2O_7$ and of acetic acid could be brought in contact with steel coupons in the absence of air. The rate of reduction of the dichromate was determined as a function of time by titration and spectrophotometrically. Changes in pH were also followed. Rates were measured with various initial concentrations of dichromate and of acetic acid and for several areas of steel surface. The effects of temperature, presence of NaCl, presence of oxygen, and order of addition of the solutions were studied. There was measurable loss of dichromate in all cases except those in which air was deliberately added. In general, the rate curves became level before all of the dichromate was reduced, with the maximum loss about 60 per cent. It was concluded that dichromate at 400 ppm was a fairly effective inhibitor

to the corrosion of steel down to pH 3.0 in the absence of oxygen even with 1000 ppm NaCl present. A mechanism for the reaction and of the corrosion inhibition is proposed.

ABSTRACT NUMBER 14

RATE OF DISSOLUTION OF SILVER IN AQUEOUS CERIC SULFATE SOLUTIONS

H. W. Salzberg, H. K. Knoetgen, and H. M. Molless
New York University
New York, N. Y.

THE kinetics of the dissolution of metallic silver in aqueous ceric sulfate has been studied and the reaction has been found to be diffusion controlled. This reaction was compared with that of the dissolution of silver in ferric sulfate solutions, in which the rate determining step is desorption of the silver ion. It is concluded that if there is a large potential difference between metal and oxidant, the process is diffusion controlled. If there is only a slight difference in potential, the reaction is desorption controlled.

As a rough estimate, potentials in excess of 0.05 volts should be accompanied by diffusion control.

ABSTRACT NUMBER 15

THE RATE OF CORROSION OF SILVER IN SOLUTIONS OF FERRIC SULFATE

H. W. Salzberg and Cecil V. King
New York University
New York, N. Y.

METALS down to copper in the emf series dissolve in ferric salt solutions at maximum, diffusion-controlled rates, with quantitative reduction of ferric to ferrous ion. Silver, however, reaches an equilibrium with only partial reduction of ferric ion, and the dissolution rate is smaller than with more active metals.

This paper reports a study of the corrosion or dissolution rate of silver in ferric salt solutions as a function of the concentration of the ions involved and of acid, of stirring speed, temperature and emf of the silver-silver ion, ferric-ferrous ion cell. The rate has been found to be greatly influenced by adsorption of ions formed in the reaction. A rate equation has been derived which includes the effects of adsorption and of the reverse reaction.

ABSTRACT NUMBER 16

THE ELECTROCHEMICAL BEHAVIOR OF ALUMINUM

II. In Solutions of Iron Sulfate

J. V. Petrocelli
The Patent Button Company
Waterbury, Connecticut

A STUDY has been made of the reactivity of pure aluminum with iron sulfate in solutions of varying acid strength. Electrode potentials, weight loss data, and polarization curves are presented, and it is shown that the reaction may be interpreted from an electrochemical point of view. The analysis of the behavior is based on the theory of the "mixed potential" which was previously developed.

ABSTRACT NUMBER 17

CORROSION RATE AND ETCH STRUCTURES OF ALUMINUM; EFFECT OF HEAT TREATMENT AND IMPURITIES

B. Roald* and M. A. Streicher**
Lehigh University
Bethlehem, Pennsylvania

THE effect of heat treatment at 575°C and cooling rate of aluminum specimens ranging in purity from 99.2 to 99.998 per cent Al on the rates of dissolution and resulting etch structures in hydrochloric acid and sodium hydroxide solutions has been studied.

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** Present address: E. I. du Pont de Nemours & Company, Experimental Station, Wilmington, Delaware.

ABSTRACT NUMBER 18

THE INFLUENCE OF SURFACE ACTIVE AGENTS ON PICKLING BRITTLENESS IN CARBON AND STAINLESS STEEL

Carl A. Zapffe and M. Eleanor Haslem
Baltimore, Maryland

CONTINUING a series of researches on the embrittlement of steel caused by absorption of hydrogen during acid pickling, the present study considers the effects of bath additions other than

pickling inhibitors—specifically the so-called surface active agents—also a foaming compound. Measurements of bendability using the specially designed wire-bend test follow quantitatively the changes produced by each reagent, used alone and in combination with inhibitors in a standard 10 per cent H_2SO_4 bath.

Both carbon steel (SAE 1020) and stainless steel (AISI 440-C) are studied. The surface active agents, fourteen in number, represent anionic, cationic, and nonionic groups, the last containing a series of polyethylene oxides of increasing molecular weights from 200 to 6000, since molecular weight is found to be an important factor. Two inhibitors are chosen to provide standard inhibited baths, one representing a type which characteristically aggravates embrittlements, the other being a specially developed reagent for minimizing hydrogen embrittlement.

From the various behaviors of these reagents and their combinations, conclusions are drawn which add some further description to the commercially important "pickling brittleness."

ABSTRACT NUMBER **18a**

METAL-SOLUTION POTENTIALS OF NICKEL IN FOREIGN ION SOLUTIONS AND THE MECHANISM OF NICKEL CORROSION

D. MacGillavry and J. H. Rosenbaum
Clark University
Worcester, Massachusetts

THE interface potentials of nickel in contact with electrolyte solutions free from nickel ions are being investigated. Usually, the potentials of these half cells keep drifting in the presence of air. If, however, oxygen is completely eliminated and kept excluded, and the nickel samples are thoroughly degassed, steady and reproducible potentials are attained for nickel in contact with phosphate solutions, in acid phosphate buffers as well as in alkaline phosphate buffers.

The metal-solution potentials of these pretreated nickel samples, with nitrogen or argon as the gas atmosphere, are much less positive. The steady potentials become rapidly more positive on admission of air; then the nickel potentials continue drifting at the much more positive levels and behave again similarly as the potentials of the untreated nickel samples.

These and other measurements have an important bearing on the probable mechanism of the corrosion of nickel.

This investigation is supported by the Office of Naval Research.

ELECTRO-ORGANIC CHEMISTRY

ABSTRACT NUMBER 19

ELECTROCHEMICAL REDUCTION OF NITROALKANES

Morton W. Leeds
Schwarz Laboratories
New York, New York
and
G. B. L. Smith
Research Department
U. S. Naval Ordnance Test Station
Inyokern, California

ELECTROCHEMICAL reduction of the nitroalkanes gives N-alkylhydroxylamines and alkylamines, the former being formed in the larger amounts and in satisfactory yields. The effects of current density, temperature, and acidity on the efficiency of the electrochemical reduction were studied and the optimum conditions for the several reactions were established. Nitromethane, nitroethane, 1-nitropropane, and 2-nitropropane were reduced and the corresponding alkylhydroxylamines and alkylamines were identified as the products of the reactions. The cathode potentials for the several electrochemical systems were measured at different current densities. In order to extend the applicability of the procedure, a nitroalcohol was reduced to a hydroxaminoalcohol.

ABSTRACT NUMBER 20

THE ELECTROLYTIC REDUCTION OF SALICYLIC AND ACETYLSALICYLIC ACIDS TO THE CORRESPONDING ALDEHYDES

James A. May
The Dow Chemical Company
Freeport, Texas
and
Kenneth A. Kobe
University of Texas
Austin, Texas

THE electrolytic method for reducing salicyclic acid to salicylaldehyde has been re-investigated, and the apparatus and procedure recommended by Tesh and Lowy has been used as a standard with which to compare new evidence. Sodium bi-

sulfite was used for fixation of the aldehyde and a 15°-18°C reaction temperature was maintained.

The results of Tesh and Lowy, which have been questioned by some investigators, were substantiated. The necessity for using boric acid in the catholyte was shown and the possibility of using a different type of apparatus was demonstrated.

The method has been applied to acetylsalicylic acid to produce acetylsalicylaldehyde in 25 to 30 per cent yield.

ELECTRODEPOSITION

ABSTRACT NUMBER 21

SURFACE PREPARATION OF NICKEL SILVER, BRASS, AND COPPER FOR ELECTROPLATING

Daniel Gray
Oneida, Ltd.
Oneida, New York

THE scope of this paper is limited to the operations in one large plating establishment. Cleaning sequences are described in detail. This descriptive matter is supplemented by a discussion of the reasons, empirical and otherwise, for the use of specific types of cleaners in critical steps of the cleaning sequences. Emphasis is placed on the advantages of full cooperation between manufacturers of abrasive and cleaning materials, the practical plater, and the chemist, for efficient and economical plating.

ABSTRACT NUMBER 22

CLEANING AND ETCHING OF ALUMINUM ALLOYS

Walter R. Meyer
Enthone, Inc.
New Haven, Connecticut

THE removal of organic and inorganic soils from aluminum alloys is discussed. Methods include emulsion cleaning, solvent degreasing, and alkali cleaning. The action of various acids on aluminum is considered, as well as activation of the surface of aluminum by alkalies and fluorides. The inhibition of alkali attack on aluminum by silicates is described.

ABSTRACT NUMBER 23

DIPHASE METAL CLEANING IN ELECTROPLATING

Foster Dee Snell and Irving Reich
Foster D. Snell, Inc.
New York, New York

DIPHASE cleaners apply solvent and aqueous solutions simultaneously to metal surfaces. The solvent exists as a separate layer or large droplets. Each phase removes the soil which it preferentially wets or dissolves. Preferential wetting is augmented by suitable surface active agents.

The need for both phases is demonstrated by converting the diphase cleaner to a stable emulsion. Cleaning efficiency then decreases markedly, though the same components are present.

Cleaning cycles are specified for use prior to electroplating. Substantial economies have been achieved by proper application of these techniques. The metal can be rendered chemically clean or left coated with an invisible rust-inhibiting film. Because of the diverse soil types removable, freedom from hazards, and susceptibility to variation, diphase cleaning techniques are very flexible.

ABSTRACT NUMBER 24

THE RELATIVE RELIABILITY OF ALUMINUM AND ZINC STARTING SHEETS FOR THE ELECTRODEPOSITION OF ZINC

Glen C. Ware and Kenneth B. Higbie
Bureau of Mines
U. S. Department of the Interior
Albany, Oregon

STARTING sheets made of zinc from three different sources were compared with aluminum starting sheets in electrolytes containing different amounts of impurities. Based on current efficiency and the length of the residence period, the three zinc materials gave about the same performance. Aluminum without the edges covered with conventional edge strips compared favorably with zinc, but when edge strips were used it gave inferior results.

ABSTRACT NUMBER 25

ZIRCONIUM AND TITANIUM AS CATHODE MATERIALS FOR THE ELECTRODEPOSITION OF ZINC

Glen C. Ware and Kenneth B. Higbie
Bureau of Mines
U. S. Department of the Interior
Albany, Oregon

ZIRCONIUM has been used as starting-sheet material for the electrodeposition of zinc from zinc sulfate solutions. Suitably tapered sheets, operated without edge strips, were extracted from the enveloping deposit without difficulty after residence periods as long as 15 days. Zirconium, aluminum, and titanium sheets were compared directly by using them together in a cell. The operating conditions necessary to deposit zinc on titanium were investigated.

ABSTRACT NUMBER 26

WATER-BREAK TYPE TESTS FOR THE EVALUATION OF METAL CLEANING

S. Spring
Pennsylvania Salt Manufacturing Company
Wyndmoor, Pennsylvania

THE water-spray pattern type of water-break test is described and some recent improvements in evaluation of metal cleaning efficiency by means of this test are reported. These involve the preparation of soiled panels, and the recording of final results. The validity and scope of water-break type tests are discussed, as well as some factors influencing the results obtained in this type of testing, as indicated by recent experimental work.

ABSTRACT NUMBER 27

THE DETECTION AND ESTIMATION OF OILS ON METAL SURFACES WITH ULTRAVIOLET LIGHT PROCEDURES

O. M. Morgan and L. F. Hoyt
National Aniline Division
Allied Chemical & Dye Corporation
New York, New York

SIMPLE ultraviolet light techniques provide a method for the detection and estimation of oils on metal surfaces. Mineral oil fluoresces

brightly under ultraviolet light while animal and vegetable oils may be caused to fluoresce by the addition of an oil-soluble fluorescent dyestuff. This fluorescence is capable of being photographed, thereby providing a method for recording the location and amount of oil residue both before and after cleaning. The method is rapid and does not require the metal to be wetted or damaged.

ABSTRACT NUMBER 28

DETECTION OF SOIL REMOVAL IN METAL CLEANING BY THE RADIOACTIVE TRACER TECHNIQUE

J. C. Harris, R. E. Kamp, and W. H. Yanko
Central Research Department
Monsanto Chemical Company
Dayton, Ohio

THE sensitivity of various methods for the determination of surface cleanliness is known in but few instances. The radioactive tracer technique as a quantitative method is used to define the apparent limits of sensitivity of the water-break, fluorescent dye, and copper plate methods.

The methods in decreasing order of sensitivity are: radioactive tracer technique, water-break, copper plate, and fluorescent dye.

Quantitative estimates of limits of sensitivity are given.

ABSTRACT NUMBER 29

SOIL REMOVAL TESTING AND CLEANLINESS EVALUATION

A. Mankowich
Aberdeen Proving Ground, Maryland

PROCUREMENT, plant control, and research relating to alkaline metal cleaning compounds are dependent on soil removal tests and methods of evaluating the degree of cleanliness attained in such tests. The chief characteristic of a soil removal test is the rigorous standardization of every step of the procedure. The main steps of a soil removal test are (*a*) preparation of test panels, (*b*) soiling of test panels, (*c*) soil removal, (*d*) rinsing, and (*e*) drying. Degree of cleanliness is evaluated by the following methods: (1) continuous water film, (2) fluorescent,

(3) radioactive tracer, (4) weight of residual soil, (5) electroplating, (6) residue pattern, (7) wiping, (8) electrical resistance, and (9) activity of surface.

ABSTRACT NUMBER 30

THE ASCYCLIC GENERATOR FOR ELECTROLYTIC PROCESSING

Gordon J. Berry
The Electric Products Company
Cleveland, Ohio

THE Ascyclic Generator offers new possibilities for electrolytic processes, much more economically than previous types of machinery. It introduces better, more efficient, and safer production processes through (1) substantial reduction of mounting area, (2) increased generator efficiency, (3) lower installation and operating costs, (4) greater dependability, and (5) flexibility.

ABSTRACT NUMBER 31

THE CATHODE POLARIZATION POTENTIAL DURING THE ELECTRODEPOSITION OF COPPER

I. The Apparent Instability of Acid Copper Sulfate Solutions and the Production of Solutions of Consistent Characteristics

L. L. Shreir and J. W. Smith
Bedford College for Women
(University of London)
London, England

UNLESS special precautions are taken, the constant state cathode polarization potential during electrodeposition of copper from $CuSO_4$-H_2SO_4 baths is decreased after the solution has been stored. At the same time the crystal structure of the deposit becomes coarser. These effects are reversed after the solution has been treated with oxidizing agents or submitted to prolonged electrolysis. Evidence has been obtained that these phenomena are due to very slight traces of impurity, formed during storage, and a method for producing solutions which yield the same polarization values after several months is described.

ABSTRACT NUMBER 32

THEORETICAL ANALYSIS OF THE CURRENT DENSITY DISTRIBUTION IN GALVANIC BATHS

Carl Wagner
Department of Metallurgy
Massachusetts Institute of Technology
Cambridge, Massachusetts

THE current density distribution at plane electrodes of finite breadth has been calculated under the assumption of a linear polarization curve. For triangular-wave profile electrodes the current density distribution has been calculated for zero polarization, and an approximate solution has been obtained for high polarization. Results of the theoretical analysis are compared to experimental data reported by Mantzell. In addition, it is shown how measurements with the Haring cell can be used to predict the current density distribution for other geometrical conditions.

ABSTRACT NUMBER 33

PLATING EXPERIMENTS WITH AQUEOUS SOLUTIONS AT HIGH TEMPERATURES

Seymour Senderoff and Abner Brenner
National Bureau of Standards
Washington, D. C.

AQUEOUS solutions of salts of chromium, copper, molybdenum, nickel, titanium, tungsten, vanadium, and zirconium were electrolyzed under pressure at temperatures up to 300°C. Under these conditions, intermediate reduction steps were favored over reduction to metal. Instability of the solutions was frequently encountered but anodic processes were improved in some cases.

ABSTRACT NUMBER 34

THE ANODE LAYER IN THE ELECTROLYTIC POLISHING OF COPPER

H. F. Walton
University of Colorado
Boulder, Colorado

THE viscosities and electrical conductivities of solutions of $CuHPO_4$ in aqueous phosphoric acid and phosphoric acid-glycerol-ethylene glycol

mixtures were measured with a view to investigating the anode layer formed when copper is electrolytically polished in these solutions. Dissolved copper was found to raise the viscosity considerably, the increase being greater in the mixtures with glycol and glycerol than in phosphoric acid alone. The copper concentration near the anode during electrolysis was measured, and current-voltage relationships were studied using a rotating copper anode. The effective thickness of the anode layer was estimated to be about 10^{-2} cm.

ABSTRACT NUMBER 35

STUDIES OF HYDROGEN EMBRITTLEMENT IN CADMIUM PLATED STEEL

Robert Weast
Case Institute of Technology
Cleveland, Ohio

THE degree of hydrogen embrittlement in a hardened SAE 1065 steel plated with cadmium is influenced by a number of variables, among which are the pre-plating operations such as acid pickling, tumbling, time between pickling and plating.

Relief of the final product was most effective when samples were cleaned without pickling as by abrading with emery or tumbling with silicon carbide dust and least effective when the conventional pickling procedures were used. However, tumbling caused a serious weakening of the steel, probably because of the effect on the surface roughness. The use of certain inhibitors in the pickling bath reduces the embrittlement from pickling but forms a loose film which must be removed before the steel is cadmium plated.

The most practical procedure for minimizing hydrogen embrittlement is to heat treat the plated stock for twelve hours at 150°C in air immediately after plating, or for two hours at 250°C in air twenty-four hours after plating.

ABSTRACT NUMBER 36

MECHANISM OF MASS TRANSFER IN CATHODE FILMS DURING ELECTRODEPOSITION

Robert R. Banks and Henry B. Linford
Columbia University
New York, N. Y.

EQUIPMENT is described which allows the delineation of the electrolyte concentration and concentration gradients, through the cathode film, at steady state.

A method was developed to determine the composition of the closest layer of electrolyte adjacent to the electrode which is free to flow.

A theory is presented to explain these results, account for the behavior of indeferent ions in electrodeposition, and explain the presence of anions at the cathode-solution interface during electroplating.

ABSTRACT NUMBER 37

ELECTRODEPOSITION OF METAL POWDERS

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Electrodeposition Section
National Bureau of Standards
Washington, D. C.

METAL powders may be produced electrolytically by two different methods: (*a*) direct deposition on the cathode, and (*b*) grinding of a brittle deposit. The principles underlying method (*a*) are covered in this paper. Three factors are shown to be responsible for the formation of powdery or spongy deposits: (1) low metal overvoltage, (2) depletion of the metal content of the cathode film, and (3) hydroxide formation in the cathode film. These factors may operate together or they may be operative under different conditions of electrolysis. Powder formation on the cathode in the electrolysis of copper, iron, nickel, zinc, and cadmium is analyzed.

ABSTRACT NUMBER 38

ELECTROLYTIC HEXAGONAL NICKEL

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Frick Chemical Laboratory
Princeton University
Princeton, New Jersey

CONDITIONS governing the formation of electrolytic hexagonal nickel in baths containing $NiCl_2$, $NiSO_4$, and H_2BO_3 were investigated. A mixed structure of face-centered-cubic and hexagonal-close-packed forms was always present in deposits made from baths containing a relatively large amount of $NiCl_2 \cdot 6H_2O \left(R^* > \frac{0.68}{0.32} \right)$ at higher current densities (>0.2 amp/dm^2) and lower bath temperatures ($<40°C$). Deposits with a mixed structure are found to contain more occluded hydrogen than deposits with a simple

face-centered-cubic structure. The possible connection between higher hydrogen content and the presence of the mixed structure under certain bath conditions is discussed.

ABSTRACT NUMBER 39

IMPROVEMENTS IN THE ELECTROWINNING OF CHROMIUM

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Bureau of Mines
U. S. Department of the Interior
Boulder City, Nevada

IMPROVEMENTS in the electrowinning of chromium from trivalent or "chrome alum" solutions, made since publication of a previous paper, are disclosed. Elimination of sodium sulfate from the electrolyte and changes in cell design have decreased the cost of electrowinning chromium metal. Details of the new cell design and data obtained with a 120-pound-per-day cell are discussed.

The sensitivity of laboratory-size cells to certain critical impurities and other variables tends to obscure the possibilities of this type of electrolyte. Research in pilot-plant cells has shown that proper cell design and operation on a sufficiently large scale can largely overcome the sensitivity of chromium sulfate electrolytes to impurities and, to a lesser extent, to pH and other variables.

ABSTRACT NUMBER 40

THE EFFECT OF PURE ORGANIC COMPOUNDS ON CRYSTAL SIZE IN COPPER ELECTRODEPOSITION, I

Martin Chanin, William P. Roth, Herbert R. Roth, and John H. Lane
Evansville College
Evansville, Indiana

A PRELIMINARY investigation of the effect of several series of aromatic isomers on the surface obtained in copper electrodeposition has been made. Plating was accomplished from very pure copper sulfate-sulfuric acid solutions, with small amounts of the organic compounds added. A definite trend has been observed. Crystal size is reduced most markedly when the ortho isomers are used. Quinone formation seems to have little to do with the mechanism involved, since the meta isomer is more effective than the para.

ABSTRACT NUMBER 41

THE EFFECT OF INDIUM IN ELECTRODEPOSITED CHROMIUM

Norman Hackerman and Tyleen Jensen
University of Texas
Austin, Texas

BY SIMULTANEOUS vapor deposition of indium and chromium an essentially crack-free plate was obtained, whereas with chromium alone by the same method the crack network normally found in the electroplate was reproduced. On the assumption that the mechanism of plate formation is the same either from vapor or from solution following ionic discharge, the two metals were codeposited electrolytically from a sulfate bath. For sufficiently high indium sulfate concentrations a very bright plate was produced which showed no cracks at 200 diameters magnification. The plate was relatively ductile and made a good protective coating for the basis metal according to salt drop tests. Indium was shown to be present by emission spectrography, but quantitatively it can only be said that it was in the plate to less than 4 per cent. The surfaces coated were copper and steel, neither of which were given any special pretreatment, and the plate was adherent in both cases.

ABSTRACT NUMBER 42

ELECTRODEPOSITION OF RHENIUM-NICKEL ALLOYS

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Victor Chemical Company
Chicago Heights, Illinois
and
M. L. Holt
Chemistry Department
University of Wisconsin
Madison, Wisconsin

THE electrodeposition of rhenium-nickel alloys from an ammoniacal citrate bath and from nickel plating baths containing potassium perrhenate is described. The ammoniacal citrate bath was used to determine the effects of such factors as bath composition, bath pH, bath temperature, and current density on cathode current efficiency and alloy composition. A plating solution which gave a cathode deposit with a high percentage of rhenium contained 66 g/l of citric acid, 56 g/l of nickel sulfate hexahydrate, 10 g/l of potassium perrhenate, and ammonium hydroxide to a pH of about 8. When this solution was electrolyzed at 5 amp/dm^2 and 70°C it gave a cathode

deposit containing approximately 78 per cent rhenium with a current efficiency of about 90 per cent. Some of the properties of electrodeposited rhenium-nickel alloys are also reported.

ABSTRACT NUMBER 43

NEW CORRELATIVE INSTRUMENTAL ANALYSES OF TEXTURES AND PROPERTIES OF NICKEL ELECTRODEPOSITS

George L. Clark and Stanley H. Simonsen*
University of Illinois
Chicago, Illinois

THE texture and properties of nickel electrodeposits, particularly with respect to the function of brighteners, have been re-examined with improved x-ray diffraction and electron micrographic techniques. Brightness cannot be ascribed to characteristic type or degree of preferred orientation, but is more closely related to grain size and other factors. Hull cell panels provide a powerful aid in studying effects of current density and thickness of deposit on the same specimen. The ratio of intensities of the two principal diffraction lines, I_{111}/I_{200} is correlated directly with tendency toward preferred or random orientation and with strain, hardness, smoothness, brightness, etc. For the first time anomalous intensity maxima on fiber patterns are found to be due to twinning of nickel crystals with consequent effects on physical properties. Remarkable shadow-cast electron micrographs of nickel deposits give new clues to differences in various types. These investigations were made possible by the close cooperation in preparing specimens of Dr. K. S. Willson, Harshaw Chemical Company, Cleveland, Ohio, to whom grateful acknowledgement is given.

* Present address: University of Texas, Austin, Texas.

ABSTRACT NUMBER 44

PREPARATION OF FINE WIRE BY ELECTROPOLISHING

William H. Colner, Morris Feinleib, and Howard T. Francis
Armour Research Foundation
Illinois Institute of Technology
Chicago, Illinois

A PROCESS and apparatus for the continuous production of fine wire by electropolishing is described. Stainless steel wire 0.00015 inch

(0.00038 cm) in diameter has been prepared. The fineness of the wire results in unusual current distribution and polishing characteristics. Curves are given relating the wire diameter with the polishing current, wire speed, and bath temperature.

BATTERIES

ABSTRACT NUMBER 45

THE MECHANISM OF THE DISCHARGE OF THE MANGANESE DIOXIDE ELECTRODE

D. Thomas Ferrell, Jr., and W. C. Vosburgh
Duke University
Durham, North Carolina

MANGANESE dioxide electrodes prepared by electrolytic deposition on graphite rods were found reproducible in discharge characteristics, though variable in magnitude and constancy of electrode potential. The polarization and recovery from polarization in several electrolytes were studied and many complete discharges were made with measurement of the capacities. A theory of the discharge mechanism is proposed on the basis of the experiments. This is based on the formation of a lower oxide at the inner surface of the manganese dioxide layer on discharge, and the diffusion of this oxide, or oxyhydroxide, into the interior of the dioxide layer. The accumulation of lower oxide during discharge accounts for much of the polarization, and the slowness of its diffusion away through the solid phase accounts for the slowness of the recovery process. Dilution of the manganese dioxide by lower oxide accounts for most of the decrease in the open circuit electrode potential during discharge.

ABSTRACT NUMBER 46

THE MECHANISM OF THE SELF-DISCHARGE OF CELLS WITH MANGANESE DIOXIDE ELECTRODES

Charles W. Jennings and W. C. Vosburgh
Duke University
Durham, North Carolina

ONE of the processes leading to self-discharge is liberation of oxygen at the surface of carbon in electrical contact with manganese dioxide,

when both are also in contact with electrolyte. The oxygen can then diffuse to the anode and react there. The liberation of oxygen in such an electrode system has been demonstrated by a voltammetric method and less directly by other experiments with manganese electrodes.

ABSTRACT NUMBER 47

DISTRIBUTION OF CURRENT IN POROUS ELECTRODES

J. J. Coleman
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AN EXPERIMENTAL test is made of the applicability of Kirchoff's law to porous electrodes. The theory is applied to a dry cell made with three bodies of mix separated from each other by paper walls wet with electrolyte. The three bodies are thus isolated electronically but connected ionically. All three are connected to the external load. Thus, the electronic current flowing into each body of mix is equal to the polarizing current in each body and hence is a measure of the rate of reduction of manganese dioxide in each body. It is shown that established theory explains the distribution of current, using two parameters determined by the current distribution data itself.

ABSTRACT NUMBER 48

MINIATURE HIGH CAPACITY R-M CELLS

Richard Clune
P. R. Mallory & Company, Inc.
Indianapolis, Indiana

DEVELOPMENT of hearing aid and miniature radio toward smaller size requires more compact cell structure. Specific structures toward accomplishing maximum capacity per unit volume are discussed.

ABSTRACT NUMBER **49**

SILVER PERMANGANATE AND PERSULFATE AS DEPOLARIZERS IN PRIMARY BATTERIES

Paul L. Howard
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Washington, D. C.

SILVER oxide and silver peroxide have been studied as depolarizers for alkaline primary batteries. In order to explore other silver compounds, a study was made of the silver permanganate and persulfate salts as depolarizers. It was found that the discharge characteristics of these depolarizers was equivalent to the silver oxide even at current densities up to 1 or 2 amperes per square inch.

ABSTRACT NUMBER **50**

MAGNESIUM DRY CELLS

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Midland, Michigan

MAGNESIUM dry cells patterned after the conventional Leclanché cell now appear to be worthy of acceptance in many applications. The cell contains an AZ31X+Ca magnesium alloy anode, MnO_2, and acetylene black cathode, an alkali or alkaline earth bromide electrolyte inhibited with a chromate, and a gel-coated paper separator. The cell is characterized chiefly by very high capacity, especially in the heavier drain types of service. Cells made during the early stages of development have stored successfully two years at 70°F, retaining more than 75 per cent of their initial capacity. Low temperature discharge properties are highly promising and tropical storage properties are outstanding.

A brief history of the development of the magnesium cell, its properties, and the effect of varying some of the cell components are presented.

ABSTRACT NUMBER **51**

CALCIUM CHLORIDE LOW TEMPERATURE DRY CELLS

Earl Otto and Harold J. DeWane
National Bureau of Standards
Washington, D. C.

IT IS shown that an electrolyte consisting of 21.2 grams $Ca.Cl_2.H_2O$, 21.2 grams $ZnCl_2$, 12.5 grams NH_4Cl, and 57.6 milliliters H_2O is the

best electrolyte for cells for general purpose discharge at −22° to −35°F.

Studies have been conducted not only of the electrolyte, but also of the depolarizing mix, the thickening agent for the paste wall, the sealing material and carbon electrodes.

Some synthetic manganese dioxides have been found to be superior to natural African ore. The replacement of ordinary cornstarch in the paste wall by certain gums gives improved discharge performance and replacement by starch derivatives gives cells with better shelf characteristics.

ABSTRACT NUMBER 52

DISCHARGE CHARACTERISTICS OF LECLANCHÉ DRY CELLS

John J. Murphy
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

TEST data and discharge characteristics are given for several cell sizes made in accordance with Signal Corps Engineering Laboratories techniques, using electro ore and three different types of separators.

The test data covers a range of discharge rates from the 5-minute rate to the 500-hour rate. The characteristics of these cells at various temperatures are also shown.

ABSTRACT NUMBER 53

EMPIRICAL EQUATION FOR THE DETERMINATION OF DRY CELL CAPACITIES AT 70°F

Charles H. Clark
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

AN EXPONETIAL equation has been derived which makes possible the calculation of service that may be expected from various size cells as made by different dry cell battery manufacturers. The equation holds true for continuous discharges through fixed resistances at 70°F and 50 per cent relative humidity to various end voltages. It is designed to assist battery engineers who are required to determine expected capacities that might be given by dry batteries under various types of application.

ABSTRACT NUMBER 54

THE ELECTROCHEMICAL EVALUATION OF MANGANESE DIOXIDE FOR DRY BATTERY USE

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National Carbon Research Laboratories
Cleveland, Ohio

THE factors governing the electrochemical behavior of manganese dioxide in dry cells has never been adequately correlated with the usual physical and chemical properties of this material. Two tests are described: (*a*) determination of the pH: potential relation in zinc and ammomium chloride electrolytes, and (*b*) determination of the extent of cathodic reduction in a continuous stream of fresh electrolyte. In combination, these tests give valuable information regarding the general suitability of a sample for dry cell use and afford a partial measure of intrinsic depolarizing capacity heretofore not obtainable by other than actual battery tests.

ABSTRACT NUMBER 55

DETERMINATION OF VOLATILE MATTER IN BLACKS

G. Benson
Shawinigan Chemicals, Ltd.
Shawinigan Falls, Quebec, Canada

THE standard procedure must be modified when dealing with blacks possessing a high structure. The procedure (unpublished) used by Shawinigan is described.

ABSTRACT NUMBER 56

NIGROMETER READINGS VS. PARTICLE SIZE OF BLACKS

K. Kaufman
Shawinigan Chemicals, Ltd.
Shawinigan Falls, Quebec, Canada

NIGROMETER readings are not proportional to particle size when comparing blacks with a different degree of structure. This has been pointed out in the literature, but further experimental results are presented.

ABSTRACT NUMBER 57

S.C.E.L. PRIMARY BATTERY—RESEARCH AND DEVELOPMENT PROGRAM

Arthur F. Daniel
Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

A RESUMÉ is given of the Research and Development Program of the Signal Corps Engineering Laboratories as regards primary batteries.

Specifically discussed are the investigations pertaining to the Leclanché, R-M, and magnesium cell systems that are being performed under the general supervision of the Signal Corps Engineering Laboratories.

ABSTRACT NUMBER 58

BATTERY LOADS VS. BATTERY PERFORMANCE

H. C. Riggs
The Electric Storage Battery Company
Philadelphia, Pennsylvania

BATTERY design has kept pace with the demand. In the past 25 years automobile motors have been getting bigger, the battery load has been getting bigger, the number of miles per year has been getting bigger, and the battery is being expected to start the motor in still colder weather. The battery, however, has remained the same size, and its cost has come down. Expanders are a proven means of improving battery performance.

ABSTRACT NUMBER 59

BEHAVIOR OF THE COMPONENTS OF EXPANDERS FOR LEAD-ACID STORAGE BATTERIES

A. C. Zachlin
Willard Storage Battery Company
Cleveland, Ohio

THE effect of various expander components depends on the proportion used and in some cases on the brand chosen. Cold capacity on in-

itial cycles is affected most by lignin, increasing with the proportion of lignin up to 0.5 per cent, but not beyond that. Barium sulfate and lamp black affect initial capacity to a lesser degree, but are influential during cycling life on cold capacity and length of service. All three components affect the structure of plate surface during the cycling life test. Charge voltage is affected by the component of expander as well as by its concentration.

ABSTRACT NUMBER 60

PRACTICAL APPRAISAL OF ADDITION AGENT IN NEGATIVE PLATES OF LEAD STORAGE BATTERIES

D. H. Haskell
W. P. Fuller & Company
South San Francisco, California

THE opinions of various contemporary investigators regarding expanding agents and cold test performance are discussed.

The automobile battery manufacurers' problem of selecting suitable combinations of oxide and expander is considered from the standpoint of three practical categories: (1) ability to pass the initial cold test; (2) ability to maintain cold test performance at sustained or increasing rate in the later stages of laboratory cycling tests; and (3) ability to give satisfactorily high current discharge rates in a car (as determined by laboratory cold test) after 10,000-25,000 miles and one to two or more years of driving.

The above tests are correlated by examples and their relative bearing on one another is developed.

An in-the-car testing program is described with special reference to cold test performance. Results are described with tables and charts.

Photomicrographs by transmitted and reflected light (Ultrapak) at low medium and high magnifications in color and monochrome are used in the form of lantern slides to illustrate the behavior of several commercial types of expanders both before and after usage in cars and on laboratory test equipment.

ABSTRACT NUMBER 61

ADDITION AGENTS FOR NEGATIVE PLATES OF LEAD-ACID STORAGE BATTERIES

II. Pure Organic Compounds

E. J. Ritchie
Eagle-Picher Company
Joplin, Missouri

THIS paper presents some of the results of an experimental study of the effects produced by the addition of pure organic compounds to the negative active material of lead-acid storage batteries. The experimental conditions used in the study were selected to show the greatest differences betwen compounds of similar structure that were members of a series. Because these conditions were not standard in the industry, they have been discussed.

The results have been grouped with respect to the organic chemistry and structure of the substances tested. Only those compounds having measurable reducing action appear to have any value as "expanders" in increasing the discharge efficiency of a lead-acid cell at 0°F.

ABSTRACT NUMBER 62

THE EFFECT OF MAGNESIUM SULFATE AND SODIUM SULFATE ON LEAD-ACID BATTERIES

Paul L. Howard and G. W. Vinal
National Bureau of Standards
Washington, D. C.

FOR many years, preparations using magnesium and sodium sulfates have been exploited as battery rejuvenators. A comprehensive study of these salts was carried out over a wide range of compositions to determine whether there was any beneficial effect on sulfated lead-acid storage batteries. High and normal rate capacities, stand loss, variation in cell temperatures on charge, water consumption, and variation in specific gravity were studied over a six-month period. A simulated field test was set up in the laboratory and final results compared favorably with actual field tests. The results showed that there was no beneficial effect on a sulfated battery by the use of either magnesium sulfate or sodium sulfate or mixtures of the two in various percentages and/or various degrees of hydration.

ABSTRACT NUMBER 63

STORAGE BATTERY "DOPES"

C. C. Rose
Willard Storage Battery Company
Cleveland, Ohio

THIS paper is a review of the situation regarding battery additives or "dopes." It attempts to review past experience with these materials, to disclose the technical and economic absurdity of their claims, and then to disclose more pertinent technical data about automotive storage battery operation which has not been used heretofore in this connection. This includes data disclosing the cause of failure from scrap battery surveys. It also includes most significant battery charge voltage characteristics, together with automotive voltage regulators and their effect upon battery service and life. It should be a final answer to this annoying and confusing question.

ABSTRACT NUMBER 64

THE EFFECT OF PIG LEAD COMPOSITION ON THE LIFE AND CAPACITY OF LEAD BATTERIES

D. H. Haskell
W. P. Fuller & Company
South San Francisco, California

RECENT changes in composition of available pig leads make it important to know the effect of bismuth on battery manufacture and performance. Automobile batteries have been built and are being evaluated.

ABSTRACT NUMBER 65

THE CONSTANT POTENTIAL ANODIZATION OF LEAD IN SULFURIC ACID SOLUTIONS

John J. Lander
Naval Research Laboratory
Washington, D. C.

RATES of attack on pure lead, anodized at constant potentials, are given by the activation equation:

$$w = nke^{\alpha zFV/RT} \int_0^t adt.$$

The corrosion product is tetragonal PbO at potentials below those for PbO_2 formation.

ABSTRACT NUMBER 66

SOME PRELIMINARY STUDIES OF POSITIVE GRID CORROSION IN THE LEAD-ACID CELL

John J. Lander
Naval Research Laboratory
Washington, D. C.

EXPERIMENTAL work shows: (1) PbO_2 undergoes solid phase reaction with Pb to form tetragonal PbO; (2) certain tin alloys of lead are more corrosion resistant than pure lead or 6 per cent Sb-Pb alloy; (3) electrolyte concentration is an important factor in the corrosion process; (4) an intermediate film of PbO_2 is formed which does not cycle to $PbSO_4$; (5) a relationship exists between growth and film formation. Theoretical explanations for these effects are proposed.

ABSTRACT NUMBER 67

CONSTRUCTION AND PERFORMANCE OF PLASTIC CONTAINER ELECTROLYTE-RETAINING LEAD-ACID BATTERIES

C. H. Endress and C. C. Rose
Willard Storage Battery Company
Cleveland, Ohio

LEAD-ACID storage batteries have certain inherent advantages in respect to high voltage, high rate and low temperature discharges, rechargeability, etc., which make them desirable for many applications other than automobile starting and lighting and similar heavy duty service. The problem was to redesign the construction so as to eliminate the excess weight of hard rubber containers and the nuisance of acid leakage, and at the same time, cover a range of sizes down to the truly miniature radiosonde—or weather balloon types. Polystyrene and similar modified plastics make attractive, practical, low-weight acid-proof and leak-proof containers and covers. Fibrite insulation retains 90 per cent of the electrolyte, and coupled with cover design, makes the batteries spill proof. Gravity indicator balls in transparent ball cages give accurate indication of state of charge in batteries with not enough free electrolyte for hydrometer readings. These batteries have been designed and used in

many sizes and shapes for special applications. They are now available in a more systematically chosen range of sizes so that in series or multiple, almost every possible combination of voltage and capacity is available within a very minimum volume and weight. Typical discharge characteristics are shown and capacity ratings of the various sizes are given.

ABSTRACT NUMBER 68

THE HYDROSET PROCESS FOR LEAD STORAGE BATTERY PLATES

R. H. Greenburg, F. B. Finan, and B. Agruss
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Research Laboratories
Brooklyn, New York

IN THE lead-acid storage battery industry, the trend has been toward the use of litharge containing high percentages of finely divided, unreacted metallic lead. Plates containing this material are cured or "hydroset" at room temperature prior to forming. The setting action involves oxidation of the metallic lead in the presence of water, an exothermic reaction causing the plates to dry. Variations in atmospheric conditions affect the rate of setting. This paper discusses the effects of temperature and humidity changes on the setting rate. There is an optimum plate moisture concentration corresponding to a maximum oxidation rate.

ABSTRACT NUMBER 69

FLOAT CHARACTERISTICS OF LEAD BATTERIES

U. B. Thomas
Bell Telephone Laboratories
Murray Hill, New Jersey

THE steady-state positive and negative plate potentials of lead-acid storage batteries with lead-calcium and lead-antimony grids were measured at various constant charging currents from 0.008 per cent to 40 percent of the eight-hour discharge rate. Above a definite minimum current, the polarization voltage follows the equation $E = A \log \frac{I}{I_o}$. A is a constant independent of temperature over the range studied (25°-40°C), while log I_o increases linearly with temperature. These constants have characteristic values for the positive and for the negative plates

which further depend on the composition of the grid alloy. Lead-calcium plates give slightly higher values for A and considerably lower values for I_o than lead-antimony. At currents less than I_o, the plate potentials correspond to the reversible potentials for the positive and negative plates, respectively.

It is shown that these data permit the calculation of the negative plate self-discharge rate, the analysis of operating conditions, and the determination of proper float voltage.

ABSTRACT NUMBER 70

NICKEL-CADMIUM BATTERIES FOR MILITARY USE

G. B. Ellis
U. S. Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey

A REVIEW is made of the performance of military types of nickel-cadmium batteries. Sintered plate batteries are compared with pocket types.

SPRING MEETING

at the

WARDMAN PARK HOTEL

Washington, D. C.

April 8, 9, 10, and 11, 1951

SESSIONS ON

Electronics
Electrothermics
Electric Insulation
Luminescence
Rare Metals
Theoretical Electrochemistry
Round Table on Industrial Electrolytics

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not later than February 1, 1951

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Westvaco Chemical Div., Food Machinery and Chemical Corp., New York, N. Y.
Willard Storage Battery Co., Cleveland, Ohio
Wyandotte Chemicals Corp., Wyandotte, Mich.

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